disappears. During prophase of the ultimate division of the spermatogenous cells, the nucleolus divides into two separate masses by constriction, and before separation is complete, a third small body buds off from one of the nucleolar bodies. These three bodies become free, but do not pass beyond the nuclear membrane, and the smallest one is considerably larger than is usually associated with centrosomes. These bodies were lost during later prophase, and their fate could not be determined. Chromosomes are constantly 6 in number and no difference in size could be observed.

The daughter nuclei at first contain several deeply staining granules, which later are replaced by a single centrally placed nucleolus. This nucleolus divides by constriction into two bodies, one of which again divides. The nuclear membrane then becomes indistinct, and two of the nucleolar bodies pass out into the cytoplasm, and probably increase by division, as more than two can often be found. Later they become rodlike and are usually grouped near a vacuole. At this stage the nucleus is barely distinguishable as a mass somewhat denser than the surrounding cytoplasm. The nucleolus may again cut off one or two bodies, which probably pass out into the cytoplasm and become associated with the rodlike bodies. These rods now increase in length, become irregularly curved, and look very much like chromosomes. Their number is usually three or four. This situation would seemingly explain the double reduction of J. and W. Docters VAN LEEUWEN-REIJNVAAN. The nucleolus now enters upon a third period of division, giving rise to two bodies which pass out into the cytoplasm, one being most likely the blepharoplast; the other WILSON thinks is perhaps the same as the "Nebenkörper" described in *Marchantia* by IKENO. All but one or two of the rodlike bodies now coalesce and form a spherical mass, which the author names the "limosphere." Later, when the limosphere is seen in optical section, it appears as a ring. In the last stages studied (the nearly mature sperms) the limosphere still persisted.

In *Atrichum undulatum* the sequence is much the same as in *Mnium*. No centrosomes could be found, and the chromosome number is 17. In *Pellia epiphylla*, centrospheres and perhaps centrosomes are present in later divisions in the antheridium. The author thinks the blepharoplast may be derived from the centrosome. A limosphere and accessory body are present in the sperm, but their origin was not determined.

WILSON'S work gives evidence of extremely careful study, and seems to furnish a satisfactory explanation for the fantastic performances which have been reported as taking place during spermatogenesis in Musci.—W. J. G. LAND.

Origin of the mitotic figure.—LAWSON'S[9] study of the microspore mother cells of *Disporum*, *Gladiolus*, *Yucca*, *Hedera*, and the vegetative cells in the root tip of *Allium* has revealed a series of stages in the development of

[9] LAWSON, A. ANSTRUTHER, Nuclear osmosis as a factor in mitosis. Trans. Roy. Soc. Edinburgh **48**:137–161. *pls. 1–4.* 1911.

the mitotic spindle which have never before been described. These new stages are to be found in the prophase immediately preceding the organization of the equatorial plate, and concern the fate of the nuclear membrane. Many authors have either described or figured the breaking down of the nuclear membrane at a time when the multipolar stage has been reached, or in vegetative cells when the polar caps have been completely formed. Contrary to the generally accepted view, LAWSON finds that the nuclear membrane does not break down or collapse at any period during the spindle development, but behaves as one would expect a permeable plasma membrane to behave under varying osmotic relations.

The nucleus is regarded as an osmotic system, and its membrane constitutes an essential element in that system. As the prophase proceeds, the nucleus or the nuclear vacuole, as he calls it, becomes smaller and smaller, and the membrane gradually closes in about the chromosomes, which later become crowded together around the nucleolus. When the karyolymph becomes so much reduced that it is no longer visible as a clear nuclear sap, the membrane becomes closely applied to and completely envelops the surface of each chromosome. As a consequence, instead of a single osmotic system represented in the nucleus, there have been established now as many independent osmotic systems as there are chromosomes.

The gradual diminution of the nuclear vacuole brings about a condition where a limited amount of cytoplasm of reticulate structure is obliged to occupy a space which has greatly increased by the reduction in volume of the nuclear vacuole. This necessarily sets up in the cell a tension sufficient to cause a readjustment and a changed configuration in the reticulate form of the cytoplasm, and therefore the cytoplasm in the region of the nuclear wall, drawn out from the reticulum by the receding membrane, becomes changed to the form of fine threads or fibrils of the "kinoplasm." The lines of tension are constantly shifting throughout the prophase. Such a shifting does not mean the changing of the threads bodily from one position to another, but it means the relaxing of the tension along certain threads, which would consequently fall back into the reticulate forms, and the setting up of new lines of tension by the drawing out of threads from the hitherto undifferentiated reticulum. Thus not only individual threads, but entire cones of fibrils may appear to assume different positions. The attachment of the spindle fibrils to chromosomes is brought about by the enveloping of each chromosome by the receding membrane.

Taking all the stages observed into consideration, the author concludes that the achromatic spindle in vascular plants is simply an expression of a state of tension in the cytoplasm, and that this tension is caused in the first place by nuclear osmotic changes that create a condition where a limited amount of cytoplasm is obliged to occupy an increased space. Thus, he regards the achromatic figure as not an active factor in mitosis, but nothing more than a passive effect of nuclear osmotic changes.—S. YAMANOUCHI.